Foam Recovery and Destruction

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ARB Workshop on Stationary High-GWP Early Action Items

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Outline

- Background
- Greenhouse Gases in Insulating Foam
- Data Sources and Inventory Development
- Emissions and Trends
- Current Recovery & Destruction Programs
- Potential Control Strategies & Costs
- Key Questions and Issues
- Working Group Formation
- Timeline & Contact Information

Background

- Foam Recovery & Destruction Program Recommended as Early Action Measure:
  - High-Global Warming Potential (GWP) Greenhouse Gas (GHG) insulating poly foams are potentially in every building, refrigerator, and freezer
  - Foams are a large source of gases that are greenhouse gases and ozone-depleting substances
  - Reduction of emissions from foam will benefit efforts to mitigate climate change and stratospheric ozone depletion

Background (continued)

- **Foams <u>Included</u> in Early Action**
  - Rigid poly insulating foams with High-GWP GHGs:
    - Polyurethane (closed cell, non-flexible)
    - Polyisocyanurate
    - Phenolic Foam
    - Spray-in Foam
    - XPS (Extruded Polystyrene) Boardstock & Panels
- **Foams <u>Not Included</u> in Early Action**
  - Materials with minimal to no GHGs:
    - Polystyrene (Styrofoam®) packaging material
    - Open cell foams (flexible polyurethane, etc.)

Banks of High-GWP GHGs in Foam

- **Banks of High-GWP GHGs in Foam**:
  - Banks are sources of gases within existing foam that is still being used as insulation in appliances, buildings, and transport refrigerated units
  - Largest source of current and future emissions are from the banks of foam
  - Banks of existing foam will continue to be an emissions source for 50-70 years

Sources of High-GWP GHG Foam Banks

- Sources of High-GWP GHG Foam Banks:
  - Building insulation (rigid poly foams) – 64%
  - Appliances (refrigerators, freezers) – 29%
  - Commercial refrigeration units – 4%
  - Transport refrigerated units – 2%
  - Miscellaneous (water heaters, picnic coolers, dashboards, surfboards) – <1%

Source: UNEP 2006 Report of the Rigid and Flexible Foams Technical Options Committee

Greenhouse Gases in Insulating Foam

Transition of High-GWP GHGs used in Foam

Foam Gas	Dates Used	ODS	GWP
CFC-11	1930s-1995	Yes	4,600
HCFC-141b	1996 – now (from stockpiles)	Yes	700
HFC-134a	2000 – now	No	1,300
HFC-245fa	2005 - now	No	950

Source: IPCC/TEAP, 2002. Safeguarding the Ozone Layer and the Global Climate System

Foam Emission Pathways

Process/Location	Loss of Gas	Note
Manufacture	4—100%	Each foam type unique
During Life of Insulation	0—2.5% per year	Average loss 1% per year
Recycling/Disposal	Up to 25%	Shredding/ breakage
Landfilled	0.5—2.5% per year	Average loss 1% per year

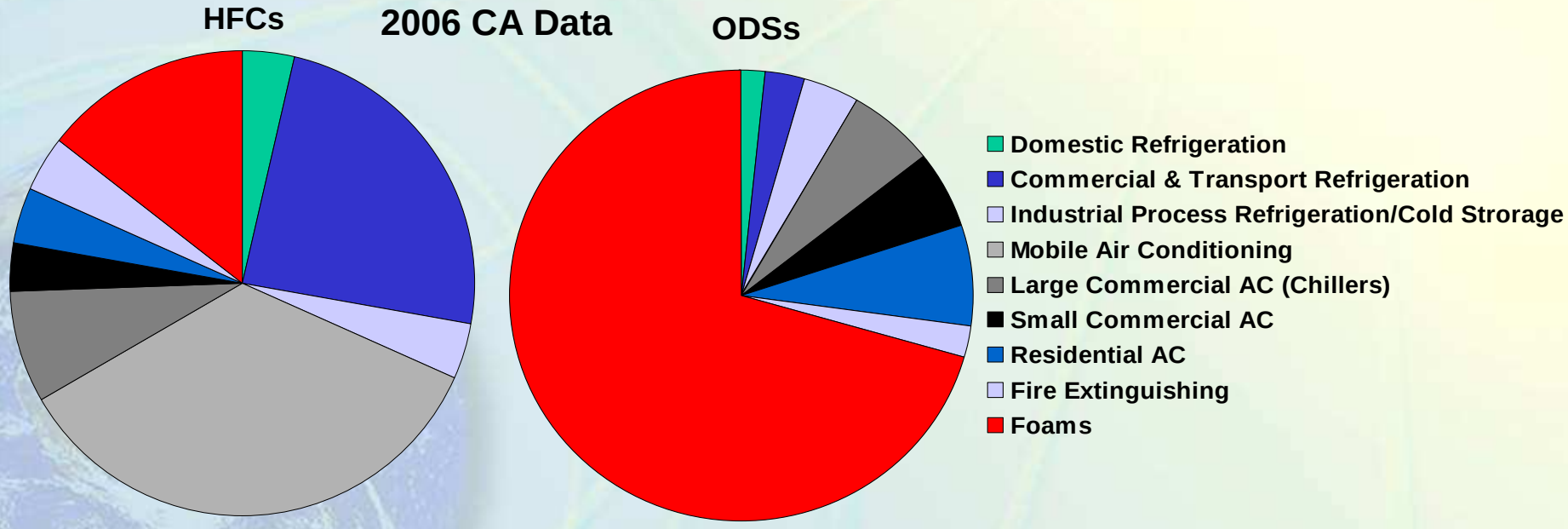
Source: USEPA, U.S. High GWP Emissions 1990-2010: Inventories, Projections and Opportunities for Reductions, EPA 000-F-97-000, June 2001 .

Data Sources and Inventory Development

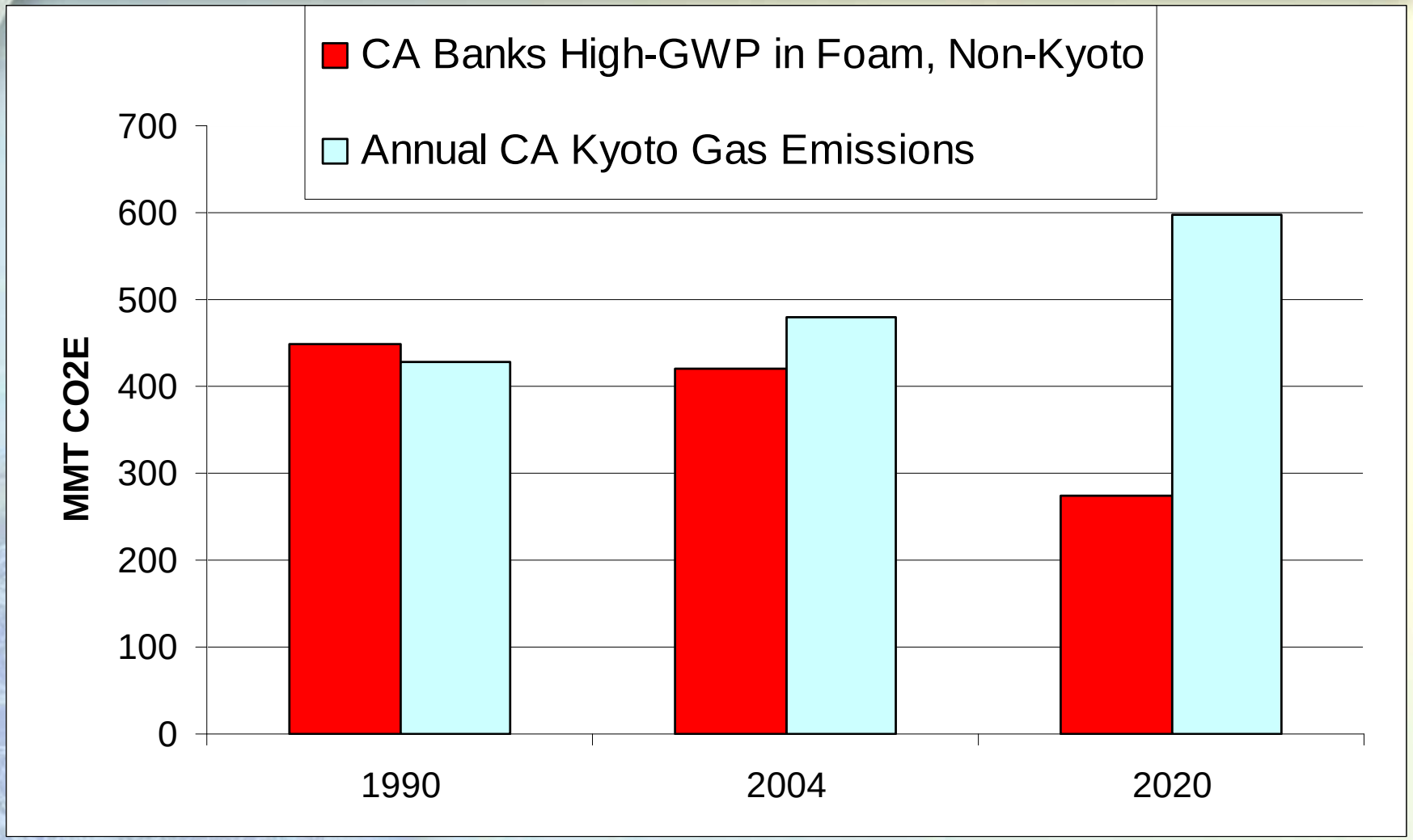
- **US EPA Vintaging Model Used to Calculate Emissions and Banks**
  - Designed specifically for ODS & High-GWP GHG stationary sources
  - Uses top-down and bottom-up data, but not 100% complete
  - National estimates scaled to California population
- Caleb Management Services
  - Will conduct a complete Foam Inventory & Emissions Study (specific to California)
  - Data available by June 2009
- Lifecycle Analysis of High-GWP GHGs to be contracted Spring 2008, completed late 2009

Banks of High-GWP GHGs in Foam
(Compared to all High-GWP GHG Sources)

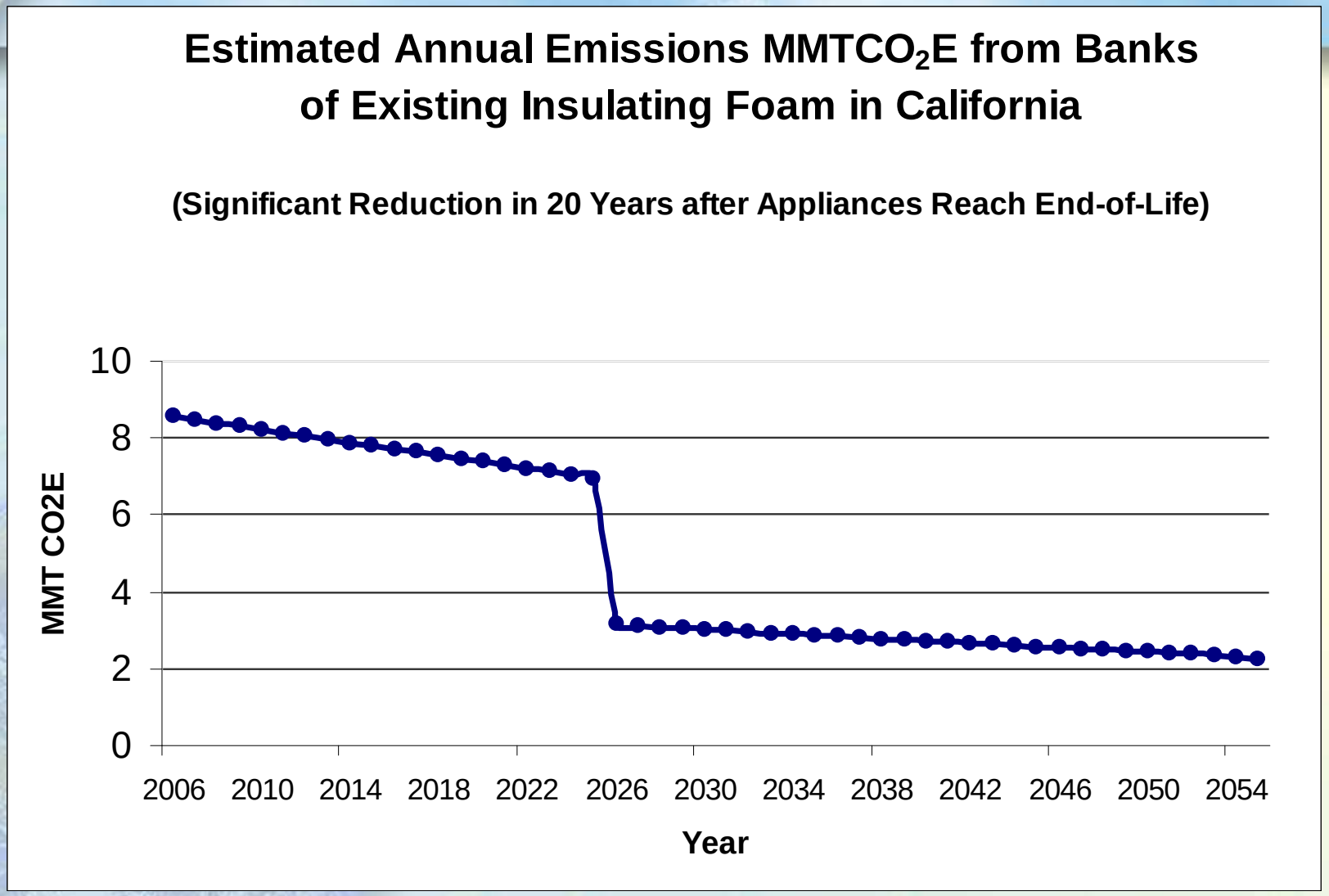
- Major CA Bank Sources (all High-GWP GHGs) in 2006 CA proportion of est. banks from USEPA, IPCC/TEAP
- HFCs ~ 80 $MMTCO_2E$; ODSs ~ 700 $MMTCO_2E$



Banks of High-GWP GHGs in Foam



Emissions and Trends - Annual

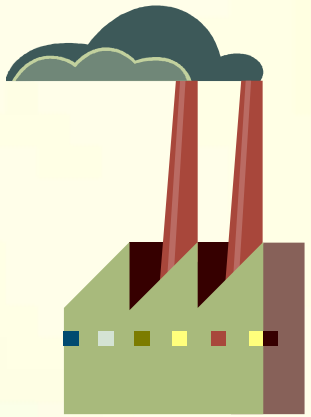


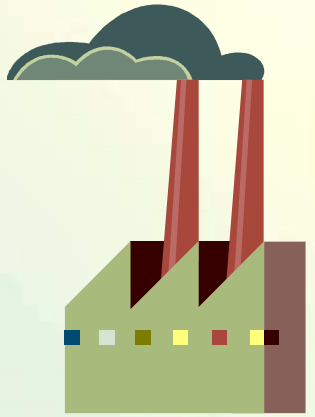
Source: US EPA Vintaging Model and 50-year extrapolation

Foam Emission Equivalents

Reducing foam GHG emissions (9 MMTCO_2E) for just one year is equivalent to any one of the following:

- Removing 1.6 million cars and light-duty trucks from road for a year
- Saving 1 billion gallons of gasoline
- Eliminating CO_2 emissions from 1.9 coal-fired power plants for a year





Current Recovery & Destruction Programs

- All current programs are voluntary
- U.S. EPA sponsors the Responsible Appliance Disposal (RAD) Program
- RAD Program does not require foam recovery & destruction, but it is a potential option
- Building insulation is not currently recovered in North America or Europe (small-scale program in Japan)

Responsible Alliance Disposal (RAD) Program

- **RAD Program:**
  - RAD partners include Sears and 4 major utility companies in California
  - Three recycling facilities in California with total refrigerant + foam recovery
  - Consumers receive $35 “bounty” for recycling old freezers and refrigerators still in operating condition
  - Appliance recyclers receive funding from utilities to take inefficient appliances off the electrical grid; and a modest premium for additional foam recovery and destruction

Potential Control Strategies

- Voluntary
  - Continue existing appliance foam recovery program
  - Expand appliance foam recovery through incentives
  - Building foam insulation recovery prior to demolition, or post-demolition separation
  - Other sources of foam - options require additional research

Potential Control Strategies (continued)

- Regulatory
  - Landfill ban on foam containing High-GWP GHGs
  - Recovery & Destruction required for end-of-life foam
  - Enforcement mechanisms not yet determined

Costs

- **Recovery & Destruction from Appliances** (estimates from US EPA Vintaging Model):
  - Automated Recovery: Approximately $6.50/MTCO_2E ($7.60/appliance)
  - Manual Recovery is very labor intensive; seven times greater cost than automated system, at approximately $48/MTCO_2E ($56/appliance)
- **Recovery & Destruction from Building Insulation:**
  - No cost data
  - Cost will be researched and included in Life Cycle Analysis (LCA) study in 2009

Key Questions and Issues

- Emissions, Banks, and Cost
- Foam gases in landfills: how much degradation, recovery and combustion efficiencies, toxic by-products
- Additional research underway
- Foam emissions & banks
- Cost of various recovery systems
- Literature review of High-GWP GHGs in landfill gas

Working Group Formation

- **Stakeholders Include:**
  - Appliance & scrap metal recyclers, construction & demolition contractors, waste management industry, local government, landfill & transfer station operators
- Form Group and meet in Spring 2008
- If Interested, Please Provide Your Contact Information

Timeline (Estimated)

Spring 2008	1st Working Group/Stakeholder Consultation Meeting
Fall 2008	1st Public Workshop to Discuss Control Strategies and Options
Spring 2009	2nd Working Group/Stakeholder Consultation Meeting
Summer 2009	2nd Public Workshop on Proposed Regulation
Winter 2009	Board Meeting on Action

Contact Information

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More Information

- Visit: http://www.arb.ca.gov/cc/foam/foam.htm
- Join list serve at: http://www.arb.ca.gov/listserv/listserv.php

Questions?